

# **Autonomous Buoyed Environmental Sensor System (ABES)**

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## **LONG-TERM GOALS**

The intent of this research effort was to demonstrate that a low-cost system of sensors could affordably yield dense spatial sampling for shallow (depth < 200 m) applications. The system would not replace existing high-resolution oceanographic instrumentation, but fill the niche for a low-cost, lower-resolution system that would provide the end user with the ability to achieve higher spatial sampling.

Under joint sponsorship of ONR-321SS and ONR-322PO, the ABES project developed and field-tested a low-cost oceanographic sensor system that gathers seafloor current, conductivity, pressure, temperature and tide data on a vertical array for a period of days to weeks before releasing a buoy which broadcasts the data via RF telemetry to a receiver.

## **OBJECTIVE**

The objective of this two-year project was to provide a prototype system demonstrating approximately 13 temperature and conductivity sensors spanning 100 m in a vertical array and field test this system in during a underwater acoustic experiment.

## **APPROACH**

The original working hypothesis that initiated this research was the idea that an array of lightweight expendable COTS sensors that utilize proven time division electrical multiplexing could provide a robust, affordable data collection apparatus for environmental sensing.

To this end, output from a variety of inexpensive sensors was multiplexed up to solid-state memory in a buoy, submerged until the data collection phase is complete. The technique demonstrated a novel time division digital electrical multiplexing data collection technique that uses one low-cost (8 dollars) analog-to-digital converter per sensor.

The system allows any variety of low-bandwidth (e.g., less than 100 Hz sampling frequency) sensors to input their output into the array backbone. Sensor conditioning electronics (e.g., preamplification, multiplexing, D/A) and mechanical issues (configuration, packaging, and sensor encapsulation) are adapted to conform to the requirements of any given sensor.

Some characteristics of the design include:

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- (1) ABES does not rely on a buoy with surface expression.
- (2) Two-wire time division digital multiplexing.
- (3) Cost in production around two thousand dollars per unit.
- (4) Spread spectrum RF LAN data relay architecture allows monitoring using a COTS RF modem in any PC located at the base station, or on the Internet. Data is also stored in flash memory in the buoy and can be retrieved if full EMCON is desired.
- (5) User-selectable sensor suite of up to 20 sensors.

## **WORK COMPLETED**

The Autonomous Buoyed Environmental Measurement System was a two-year project that started 1 Jan 96. At the start of FY98, work had been in progress for 21 months. Several incremental sea tests were conducted from Scripps Pier to demonstrate the RF link and the entire end-to-end system was validated during the ARPA Santa Barbara Channel Experiment in April 1998. Results from this experiment will be presented at the special session on rapid environmental assessment during the Spring 1999 Acoustical Society of America conference.

Building on the success of the Santa Barbara Channel Experiment, the prototype ABES instrument will be used to provide water-column measurements pertinent to underwater acoustics during the TTCP Rapidly Deployable Systems Experiment in the Timor Sea to be held in October 1998.

## **IMPACT/APPLICATION**

Possible long-term applications for the outcome of this work are numerous, including monitoring of sewage outfalls, river estuaries, power plant discharge, mine reconnaissance and pre-surveillance for amphibious operations. There is commercial applicability as an alternative to the expensive and relatively cumbersome Norwegian Sea Watch system now being marketed to American customers.

The transition potential is to an expendable, inexpensive sensor suite that would be covertly installed at several candidate sites approximately one week prior to the deployment of a surveillance system.

In a fleet system, the instruments would collect environmental data and provide this information to the mission planners prior to array deployment, facilitating optimized placement of the surveillance system.

PMW-185 (Mr. Steve Payne) is undertaking a project in FY99 to further study the potential applicability of low-cost sensors.

## **PATENTS**

After one round of resubmission, the US Patent Office accepted all 14 claims under Navy Case Number 77247, a patent application entitled "A Buoyed Sensor Array Communication System", J. R. Olson, J. M. Stevenson, and B. J. Sotirin, that was filed May 96. This resulted in U.S. Patent 5,663,927.

## **STATISTICAL INFORMATION**

Five students from San Diego State Univ. worked on this project. One of them was a woman.

A 24-thousand-dollar contract to Scripps Institution of Oceanography was executed as part of the ABES RF link task.

## **PUBLICATIONS**

Stevenson, J. M. 1998: An In-Situ Technique for Measuring Water Column Variables Pertinent to Littoral Acoustic Surveillance, in review, J. Underwater Acoustics.

McDonald, V. K., Stevenson, J. M., Briest, S. G., and Olson, J. R., 1998: Autonomous Buoyed Environmental System, Proc. I.E.E.E. Oceans 98, 1, 549-553, 1998.

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